



INTERSTATE 77 TECHNICAL MEMORANDUM

DECEMBER 2021

PURPOSE

In 2020, following the creation of the I-81 Corridor Improvement Program (CIP), the General Assembly of Virginia directed the Commonwealth Transportation Board (CTB) to establish the Interstate Operations and Enhancement Program (IOEP) to improve the safety, reliability, and travel flow along interstate highway corridors in the Commonwealth. The purpose of this study is to identify a package of targeted operational, multimodal, and capital improvements that are expected to improve travel along the I-77 corridor in Virginia.

Under the IOEP legislation, improvements identified along Interstates 81, 95, and 64 receive dedicated funding, while improvements on the other interstate corridors, including Interstate 77, are eligible for the remaining IOEP funding at the discretion of the CTB. The operational, multimodal, and capital improvements proposed through this study may utilize IOEP funds or other funding mechanisms.

CORRIDOR CHARACTERISTICS

Interstate 77 (I-77) is a north-south highway that stretches from the Virginia-North Carolina border to the Virginia-West Virginia border and coincides with I-81 for approximately eight miles in Wythe County. The resulting length of the I-77 corridor is approximately 60 miles and traverses three counties, two cities, and two Virginia Department of Transportation (VDOT) construction districts (Bristol and Salem), as shown in **Figure 1**.



Figure 1: Study Area for I-77 Corridor Study

The I-77 corridor serves as an important connection from the southeastern states to Ohio and the Great Lakes region. Most travel on the I-77 corridor is through traffic, with a significant amount of freight carried by heavy vehicles. There are two tunnels on the northern section of I-77—the Big Walker Mountain Tunnel and the East River Mountain Tunnel—that contribute to operational challenges and incident management in rare, but severe, tunnel fires.

Furthermore, I-77 is a mountainous corridor, with significant changes in elevation and sections of steep grade that have unique implications to traffic operations, especially truck travel. **Figure 2** presents the elevation profile of I-77 and highlights the steep and long grades for northbound I-77 on Fancy Gap Mountain and approaching the Big Walker Mountain Tunnel.

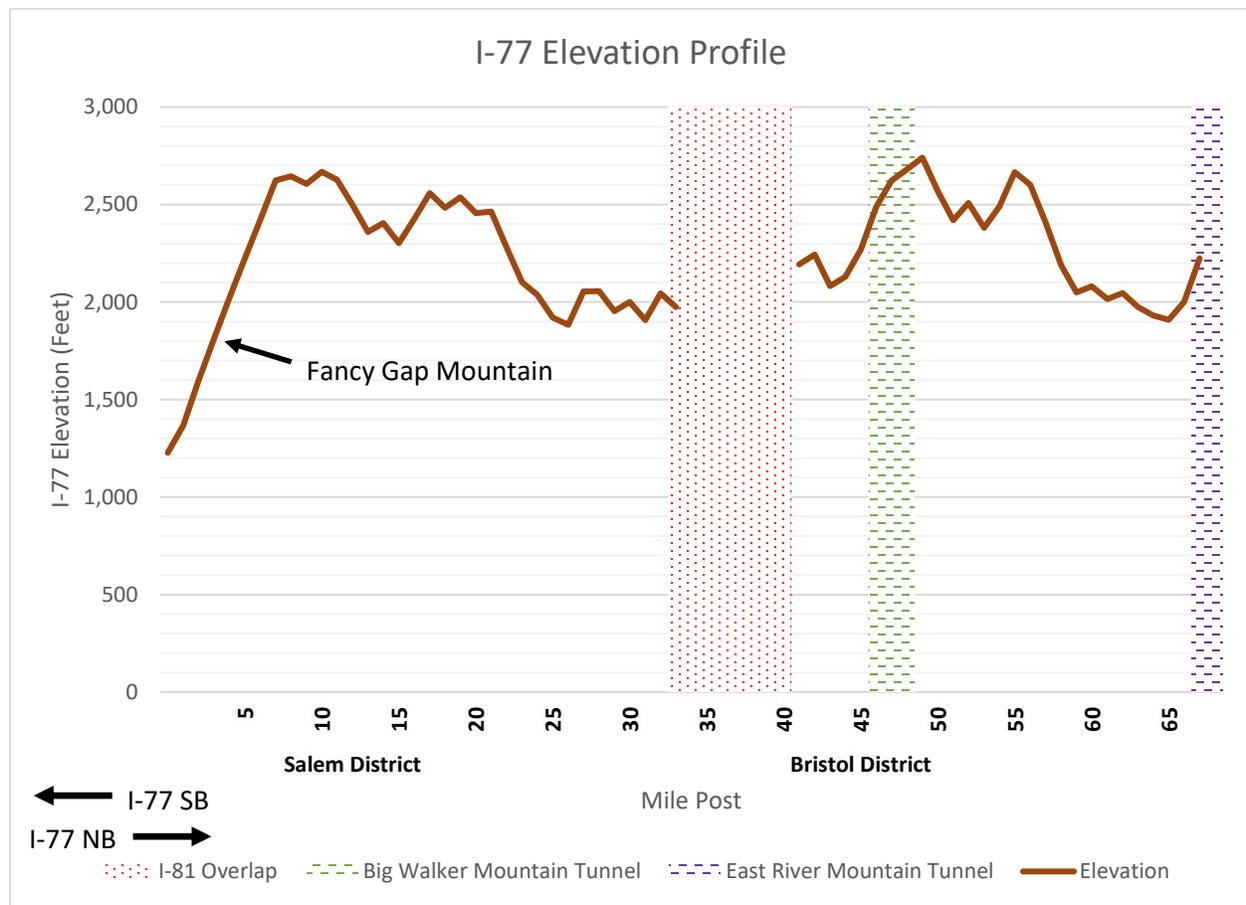


Figure 2: I-77 Elevation Profile

The presence of steep grades and tunnels has a significant impact on operations, including the speed differential and prevalence of incidents. **Figure 3** and **Figure 4** show the average speeds on northbound and southbound I-77.

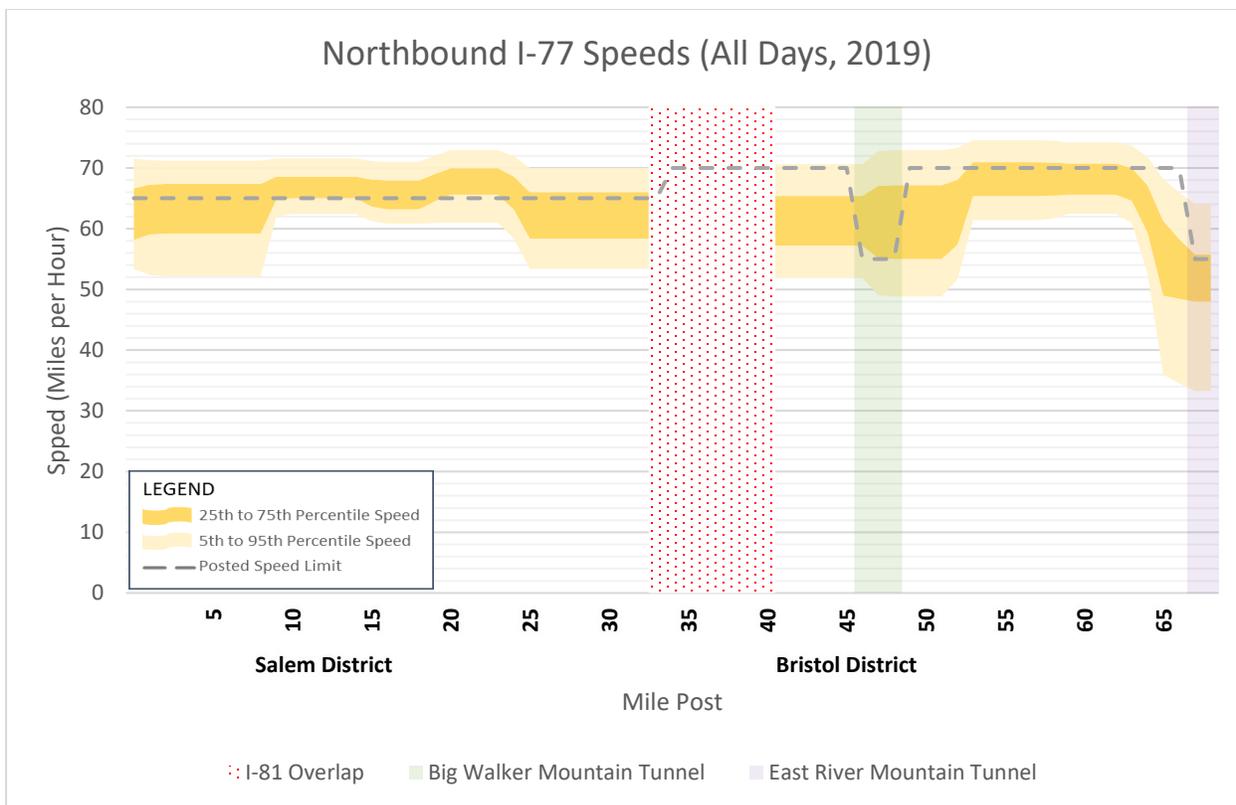


Figure 3: Average Speeds on Northbound I-77 (All Days, 2019)

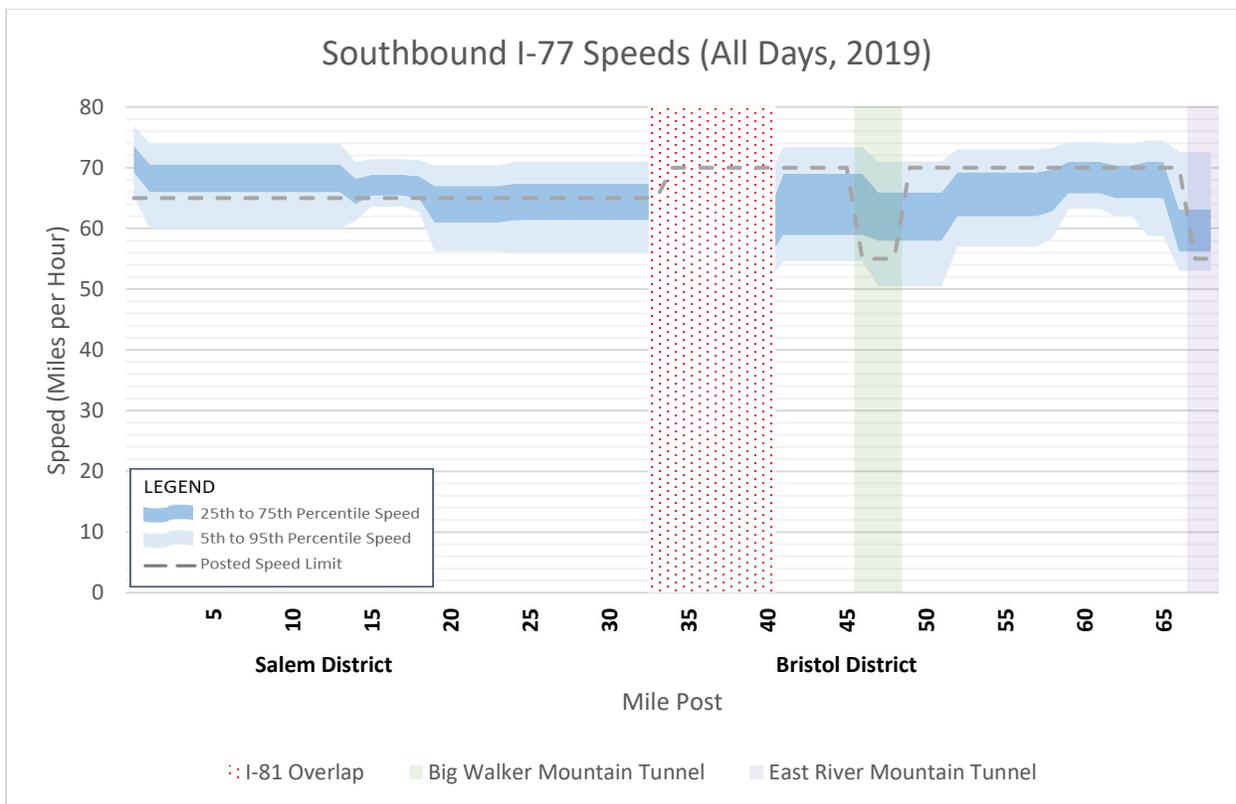


Figure 4: Average Speeds on Southbound I-77 (All Days, 2019)

EXISTING CONDITIONS

To understand the current travel conditions in the corridor, the study team gathered data from a variety of sources. This data included travel speeds; numbers and types of crashes; numbers, types, and durations of incidents; origins and destinations of passenger cars and trucks; numbers and types of traffic; and multimodal service.

Depending on the time of day, the day of week, and the month of the year, travel in the corridor varies greatly. These differences were important to understand as the study team developed potential improvements.

PERFORMANCE MEASURES

Various performance measures were compiled and analyzed to evaluate the existing conditions on I-77. The study team determined appropriate locations for foundational operational strategies using the following performance datasets:

- **Traffic volume:** The average annual daily traffic on a segment of the interstate. Source: VDOT Traffic Engineering Division.
- **Percentage of traffic volume that is trucks:** Source: VDOT Traffic Engineering Division
- **Number of incidents:** The total number of reported crash and disabled vehicle incidents on the mainline of the interstate. For some analyses, only lane-impacting incidents were considered. Source: VaTraffic

Based off the methodology employed on the I-81, I-95, and I-64 corridor improvement studies, the study team developed four performance measures to evaluate the existing operational and safety issues throughout the corridor. The team collected and summarized crash, delay, and Annual Average Daily Traffic (AADT) data for 5 years, from 2015 through 2019, in 1-mile segments by direction. After inspection of the delay data, the study team removed 2018 total delay and incident delay data from the summarization as significant work zone-related congestion skewed the 2018 data. For segments along I-77 that intersected with I-81 or the West Virginia state line, the team measured the segment to the nearest I-77 milepost and normalized the data on a per-mile basis. The study team then ranked the 1-mile segments and highlighted the top 20 percent of segment performance issues, regardless of direction, to be reviewed for potential improvements. The four performance measures include:

- **Crash frequency and severity:** The total number of crashes, weighted by severity using the equivalent property damage only (EPDO) scale. Source: VDOT Roadway Network System
- **Crash severity rate:** The total rate of crashes, weighted by severity, per 100-million-vehicle-miles traveled (100M VMT). Source: VDOT Roadway Network System and VDOT Traffic Monitoring System
- **Total delay:** The total person hours of delay caused by the impacts of congestion, incidents, and weather events. Source: INRIX
- **Incident delay:** The total person hours of delay caused by incidents (crashes and disabled vehicles) that led to the closure of at least one lane of the interstate for an hour or longer. Source: Regional Integrated Transportation Information System

A histogram detailing the EPDO crashes per mile is shown in **Figure 5**. Crash frequency and severity hot spots are found throughout the corridor and are most prevalent approaching the two tunnels in both the northbound and southbound direction and in the southbound direction approaching the North Carolina border.

Figure 6 presents a histogram that details the crash severity rate along I-77 and normalizes crash severity based on vehicle miles traveled. The crash severity rate hot spots appear in similar areas to crash frequency and severity hot spots. The most severe crash severity rate hot spots are approaching the I-81 overlap in the southbound direction and approaching the East River Mountain Tunnel in the northbound direction.

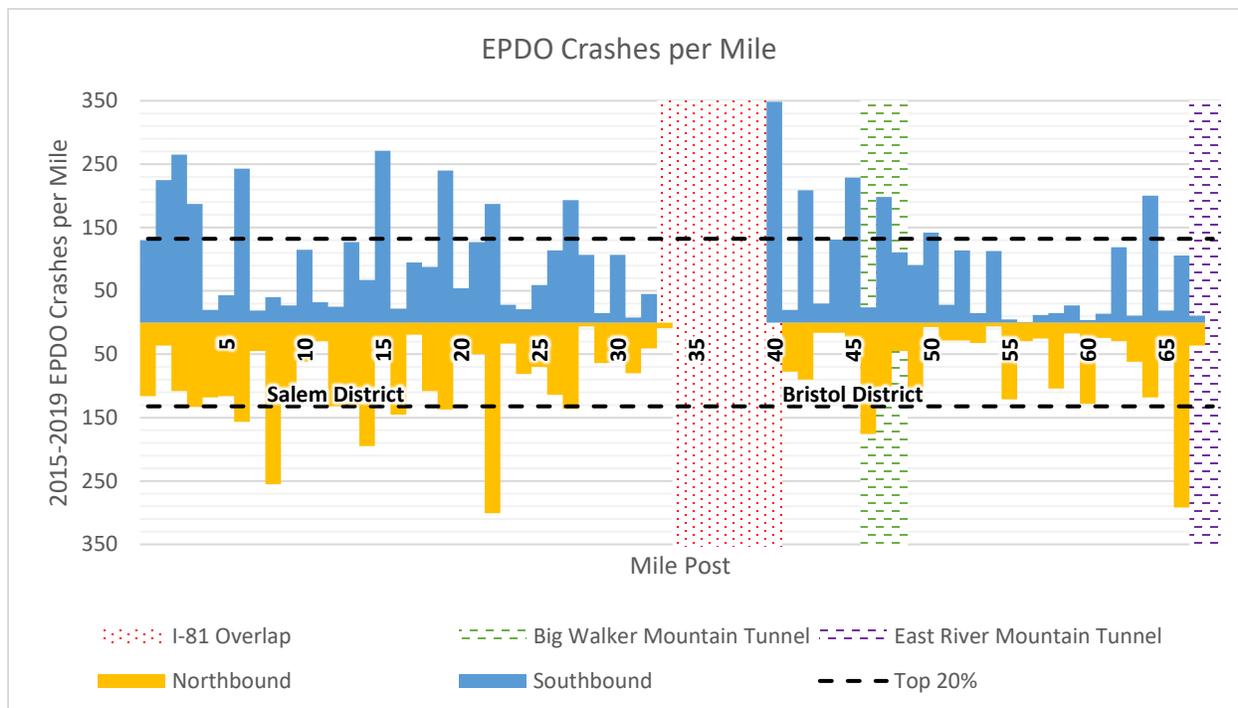


Figure 5: Equivalent Property Damage Only (EPDO) Crashes per Mile. Source: VDOT Roadway Network System

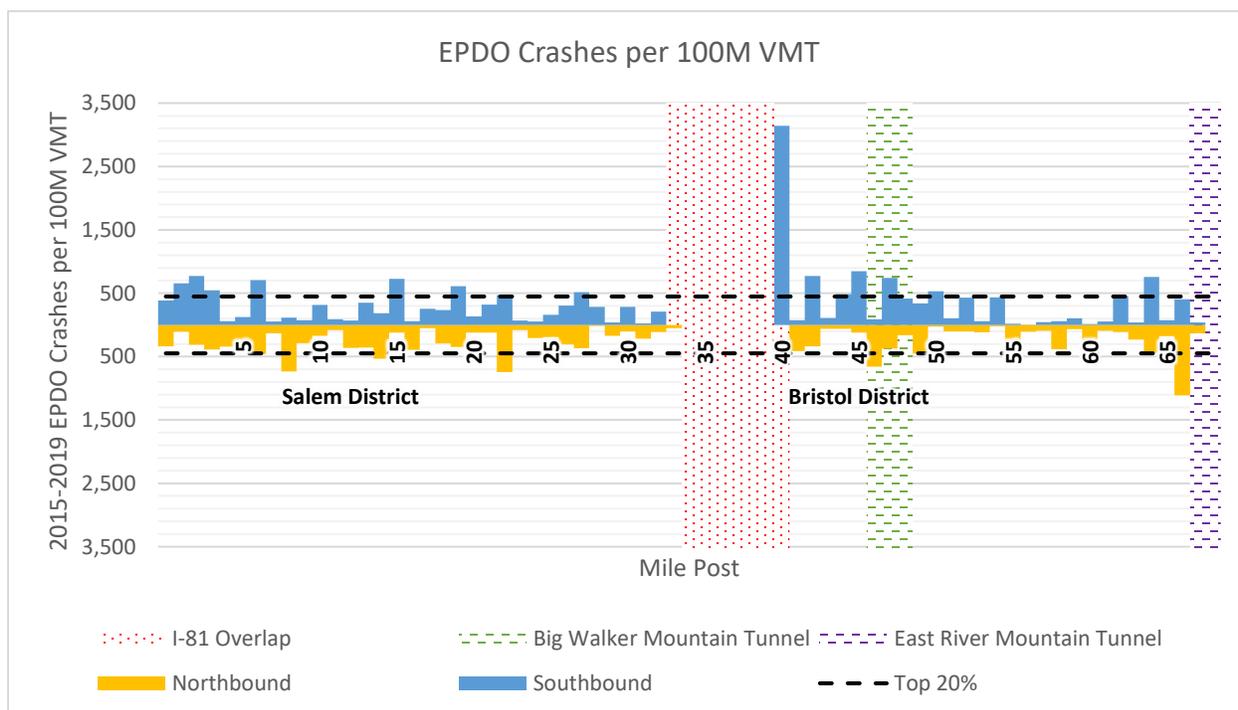


Figure 6: Equivalent Property Damage Only (EPDO) Crashes per 100M VMT. Source: VDOT Roadway Network System and VDOT Traffic Monitoring System

Figure 7 and

Figure 8 present the annual person hours of total delay and incident-related delay on I-77. The total delay histogram provides evidence that tunnel operations on I-77 have significant impacts on delay on I-77. However, in comparison to the rest of the corridor, tunnels seem to have less of an impact on incident-related delay, as shown in

Figure 8. Incident-related delay hot spots are most prevalent along I-77 south of the I-81 overlap.

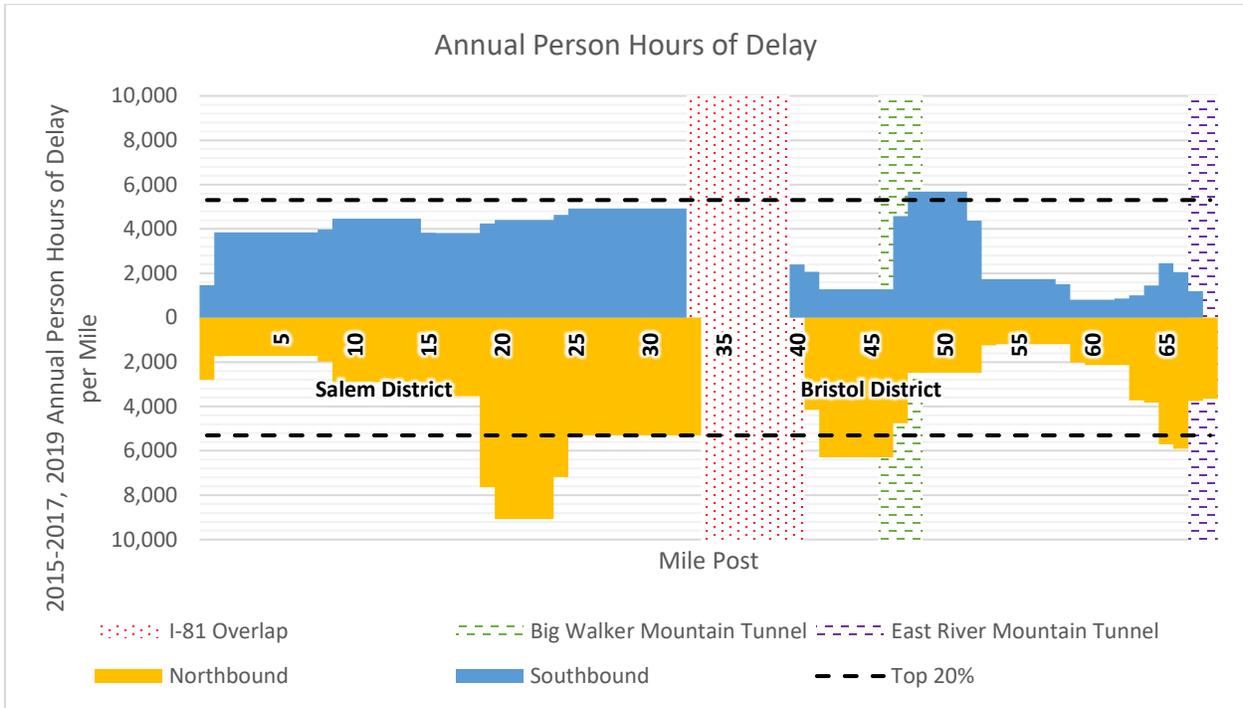


Figure 7: Annual Person Hours of Delay. Source: INRIX

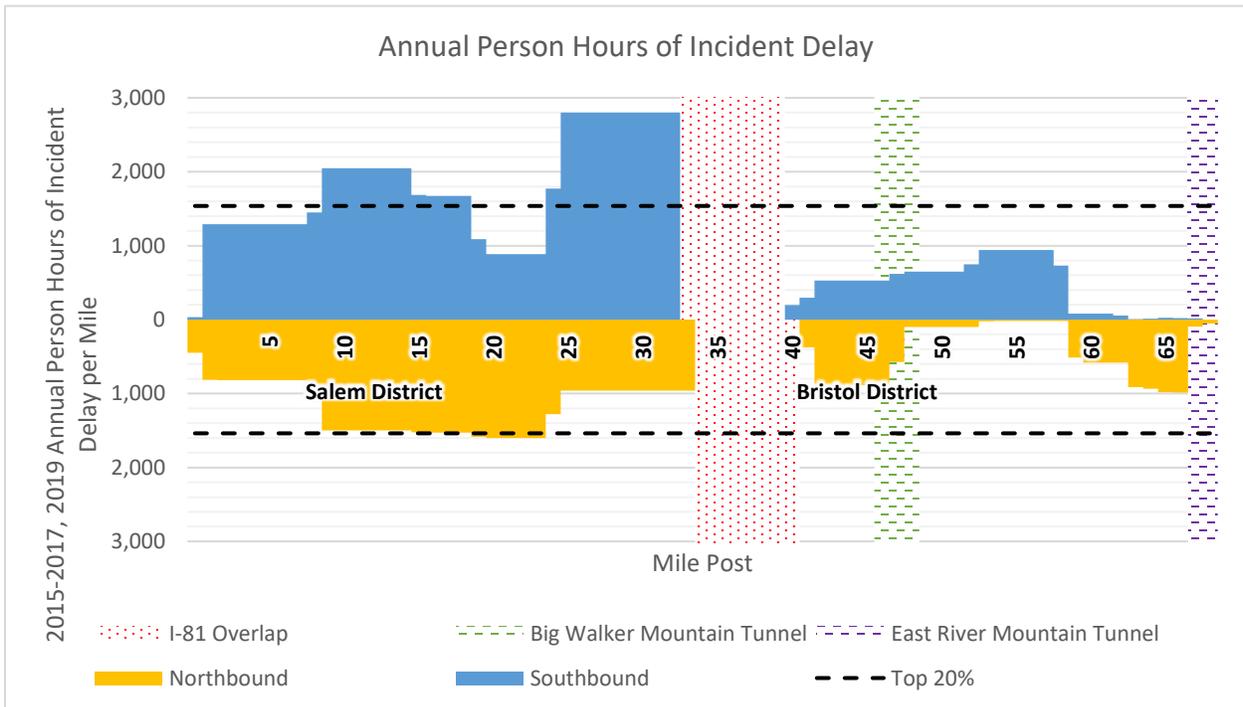


Figure 8: Annual Person Hours of Incident-Related Delay. Source: Regional Integrated Transportation Information System

SUPPLEMENTARY DATA

The study team collected and summarized additional data to supplement the four performance measures for the identification of problem areas and project development. The supplementary data includes the following information:

- **Speed data:** The study team collected INRIX data in 15-minute intervals to summarize average speed patterns and variability in speeds throughout the corridor per time of day, day of week, and time of year for 2019.
- **Origin-destination data:** The study team collected StreetLight data and summarized origin-destination patterns on I-77 in 2019 by time of day and day of week. The analysis of this data highlighted that there are more through trips along I-77 relative to trips that begin and end on I-77 in Virginia.
- **Incident data:** The study team collected and summarized additional incident data from VA Traffic in 2016 and 2017, including the number of total or lane-impacting incidents and the average time to clear a lane or scene.

A review of the incident data on I-77 revealed that incidents have a greater influence on congestion relative to other Virginia interstates. Incidents account for nearly half of congestion along I-77, double the proportion of incident-related congestion for all Virginia interstates. Furthermore, the study team summarized incidents resulting in the closure of at least one lane on an interchange-to-interchange basis. **Figure 9** provides visual evidence of how the presence of tunnels and steep grades contribute to higher rates of incidents. The review of incidents reveals a hot spot of lane-impacting incidents on the mountainous stretch of I-77 northbound between the North Carolina border and Exit 8, along with significant spikes in the frequency of incidents at the East River Mountain Tunnel.

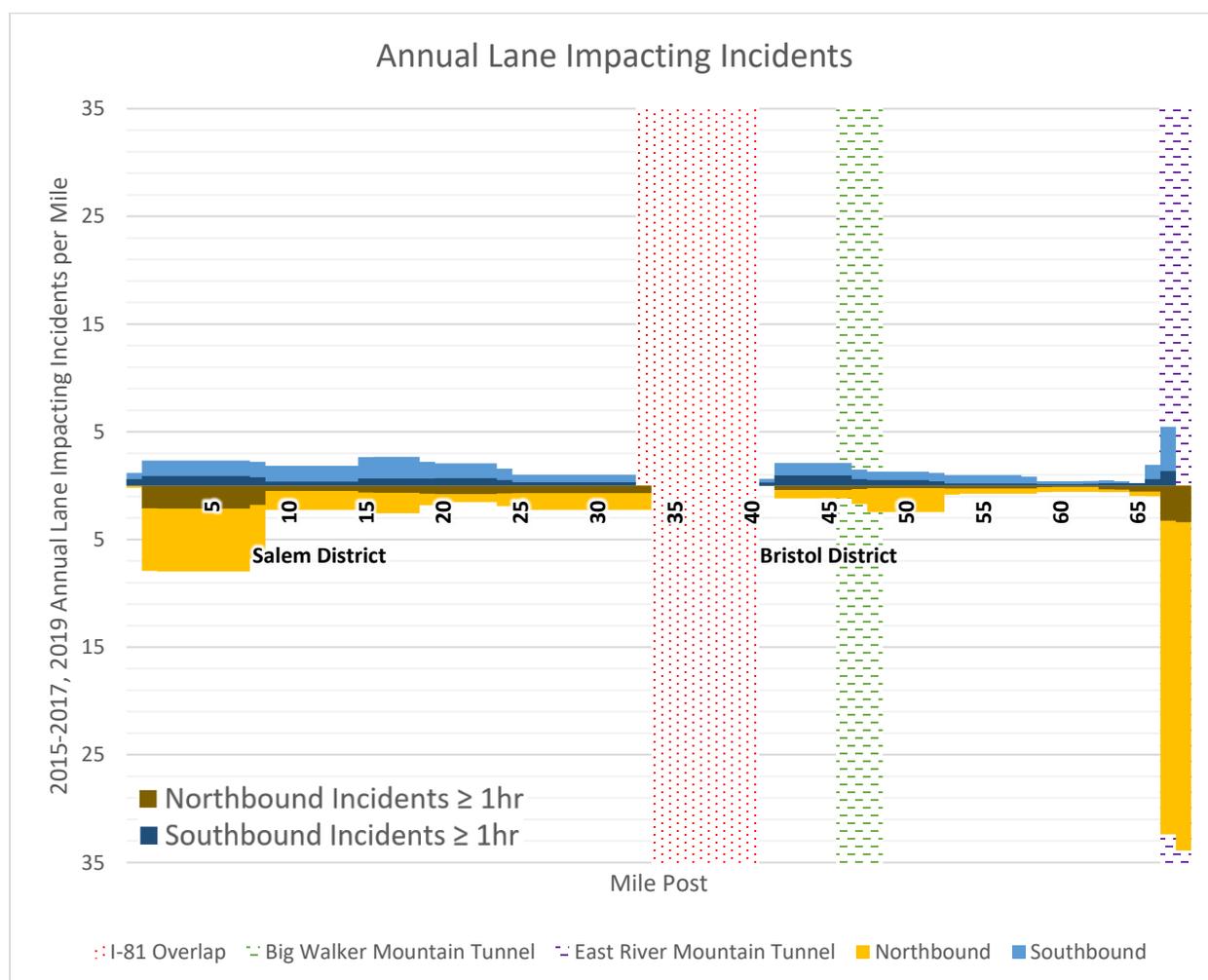


Figure 9: Lane Impacting Incidents on I-77 (2015-2017, 2019)

PROJECTS COMPLETED BY 2026

The study team reviewed projects already funded in the VDOT Six-Year Improvement Program (SYIP) to determine how those projects may resolve issues in the corridor. This exercise enabled the study team to focus efforts on proposing operational and capital improvements on segments of the corridor that did not already have programmed improvements to mitigate the identified performance issues. The study team considered the potential benefits of the following funded or recently completed projects:

- Median barrier installation on I-77 from MP 41.7 to MP 46.7
- Bridge replacement on I-77 over Cover Creek in Wythe County, VA
- Traffic management system installation at Big Walker Mountain Tunnel
- Recently completed projects include
 - Fancy Gap communications fiber
 - Fancy Gap Variable Speed Limit system
 - Highway widening efforts

MULTIMODAL CORRIDOR CHARACTERISTICS

The I-77 corridor is predominantly rural, with existing multimodal services and facilities. Mountain Lynx Transit provides bus services in Bland, Wythe, and Carroll Counties. Mountain Lynx provides fixed-route and on-demand paratransit service where customers are picked up at or near their homes. The Mountain Lynx Transit 2020 Transit Development Plan proposed doubling service of the existing Wytheville loop routes, which serve stops adjacent to the I-81/I-77 interchange in Wytheville. The Virginia Breeze Highlands Rhythm Intercity bus route, which launched in November 2021, connects Bristol to Washington, D.C. with a stop in Wytheville. Furthermore, Greyhound provides intercity bus service along the greater I-77 corridor, with a stop in Wytheville connecting to Charleston, WV to the north and Winston-Salem, NC to the south via I-77. Amtrak service is not available along the corridor. The Department of Rail and Public Transportation (DRPT) Virginia Breeze Expansion Alternatives Analysis, published in 2019, did not recommend any additional intercity bus routes serving the I-77 corridor.

The I-77 corridor has two park-and-ride lot facilities with notable utilization—one at Exit 19 and one at I-81 Exit 80 on the I-81/I-77 overlap. A statewide park-and-ride facility survey conducted in 2018-2019 documented the occupancy and identified potential improvements for the facilities along the I-77 corridor, as detailed in **Table 1**. Both park-and-ride lots lack official wayfinding signage, although there is clear use of the lots for ridesharing.

Table 1: I-77 Corridor Park-and-Ride Facility Inventory (2018 data)

Park-and-Ride Location	Total Spaces	Occupied Spaces (Occupancy)	Potential Improvements
I-81 Exit 80 (I-81/77 Overlap)	50	20 (40%)	<ul style="list-style-type: none"> • Stripe parking spaces (including ADA spaces) • Install official signage
I-77 Exit 19	28	9 (32%)	<ul style="list-style-type: none"> • Restripe pavement markings • Install official signage and wayfinding signage

OPERATIONS IMPROVEMENT PLAN

Given the prevalence of non-recurring delay on I-77, the VDOT Operations Division team developed a corridor-wide, performance-driven operations and incident management plan (Operations Improvement Plan) with the objective to get traffic moving after an incident by detecting, responding to and informing travelers, and clearing incidents.

The team identified operational strategies to maximize the effectiveness of the existing infrastructure. Key components of the Operations Improvement Plan include additional closed-circuit television (CCTV) cameras to detect incidents, portable changeable message signs (PCMS) to inform the public, the expansion of the towing recovery incentive program (TRIP) to respond to a crash or breakdown, public safety answering point (PSAP) integration to expedite incident response and communications, and upgrades of safety service patrol (SSP) vehicles to enhance the safety and visibility of incident response vehicles. **Table 2** presents the proposed operational improvements and includes the estimated capital (Year 1 service) and operations and maintenance (O&M) costs.

Table 2: Summary of Proposed Operations Improvements

Proposed Improvement	Location	Capital Cost	Annual O&M
CCTV Camera on I-77	I-77 Exit 19	\$185,000	\$5,000
CCTV Camera on I-77	I-77 Exit 24	\$185,000	\$5,000
Towing Recovery Incentive Program	Entire I-77 Corridor	\$150,000	\$270,000
PSAP Integration	Wythe, Bland, Carroll County	\$270,000	\$0
2 PCMS for Detour Use	Christiansburg Residency	\$70,000	\$2,000
2 PCMS for Detour Use	Lebanon Residency	\$70,000	\$2,000
2 PCMS for Detour Use	Wytheville Residency	\$70,000	\$2,000
SSP Hazard Devices	All SWRO SSP Vehicles	\$23,000	\$23,000
Total		\$1,023,000	\$309,000

The study team also identified improvements recommended for consideration if funding is available, shown in **Table 3**. A key recommendation is for the development of incident detour plans for the I-77 corridor. The Interstate 77 Corridor Improvement Plan (March 2021) produced by the VDOT Operations Division provides further details on the Operations Improvement Plan and methodologies employed to develop improvements.

Table 3: Summary of Operations Improvements Recommended for Consideration

Proposed Improvement	Location	Capital Cost	Annual O&M
Corridor Incident Detour Plans	Entire I-77 Corridor	\$30,000	\$0
CCTV Camera on US 460	US 460 and Route 61, Narrows	\$50,000	\$5,500
CCTV Camera on US 460	US 460 at the WV State Line, Glen Lyn	\$185,000	\$5,500
CCTV Camera on US 460	US 460 and Commerce Dr, Bluefield	\$50,000	\$5,500
CCTV Camera on US 19	US 19 and US 460, Claypool Hill	\$50,000	\$5,500
CCTV Camera on US 19	US 19 and Route 609 (Wardell Rd), Wardell	\$50,000	\$5,500
CCTV Camera on US 19	US 19 and Route 80, Rosedale	\$50,000	\$5,500
CCTV Camera on US 19	US 19 and US 19 BUS, Lebanon	\$50,000	\$5,500
CCTV Camera on US 19	US 19 and US 58 ALT, Hansonville	\$50,000	\$5,500
PSAP Integration	Giles, Russell, Tazewell County	\$270,000	\$0
Total		\$835,000	\$44,000

MAINLINE ROADWAY IMPROVEMENTS PLAN

Upon reviewing the performance measures, supplementary data, roadway conditions, programmed projects, and receiving input from VDOT, the team developed a capital improvements plan for I-77. The following types of roadway improvements were considered.

- **Acceleration or deceleration lane extension:** longer lengths to accelerate and decelerate when exiting the interstate.
- **Auxiliary lane:** construction of an extra lane to connect on- and off-ramps between closely spaced interchanges to reduce the impacts of traffic entering and exiting the interstate.
- **Median guardrail:** barrier in traversable medians having little to no change in grade and cross slope.
- **Superelevation correction:** superelevation is improved or restored along curves where the actual superelevation is less than optimal.
- **Truck climbing lane:** an extra lane to separate trucks and other vehicles on uphill grades. The lane ends on the downhill side of the grade.

Table 4 and **Table 5** show a summary of mainline improvements and includes the location, direction, a brief description, targeted performance measures, a cost estimate, and whether the improvement was advanced to project prioritization in the IOEP. Superelevation and median guardrail improvements were not selected to compete for IOEP funding because these improvements were considered potential systemic safety and maintenance improvements. Following project prioritization, the IOEP process did not recommend any I-77 capital improvement projects to receive IOEP funding. Cost estimates are presented in 2020 dollars and use a combination of VDOT Statewide and District averages, the Statewide Planning Tool, and previously completed projects. Cost estimates for projects included in the IOEP prioritization process were refined to reflect the potential impacts of inflation.

Aside from the improvements proposed in the mainline roadway improvements plan, there were no locations or interchanges identified for future study.

Table 4: I-77 Capital Improvement Summary: Salem District

The following symbols represent the four performance measures:

● Crash Frequency and Severity | ● Crash Severity Rate | ● Total Delay | ● Incident Delay

Location	Mile Post From – To	Description	Performance Measures	Est. Cost (Low – High)	IOEP Project
Salem District					
I-77 SB: Exit 1	0.60 – 0.89	Extend acceleration lane	● ● ● ●	\$3.0M - 4.3M	Yes
I-77 SB: Exit 1	1.08 – 1.25	Extend deceleration lane	● ● ● ●	\$2.5M - 3.7M	Yes
I-77 SB	2.15 – 3.39	Conduct superelevation correction	● ● ● ●	\$4.0M - 5.4M	No
I-77 SB	6.12 – 6.45	Conduct superelevation correction	● ● ● ●	\$1.5M - 1.9M	No
I-77 NB	6.16 – 6.49	Conduct superelevation correction	● ● ● ●	\$1.4M - 1.9M	No
I-77 SB	7.81 – 8.78	Construct median guardrail between Blue Ridge Parkway overpass and Exit 24	● ● ● ●	\$0.3M - 0.4M	No
I-77 SB: Exit 8	8.29 – 8.53	Extend acceleration lane	● ● ● ●	\$4.0M - 5.9M	Yes
I-77 NB: Exit 8	8.43 – 8.56	Extend deceleration lane	● ● ● ●	\$2.7M - 3.9M	Yes
I-77 NB: Exit 8	9.03 – 9.29	Extend acceleration lane	● ● ● ●	\$3.6M - 5.2M	Yes
I-77 SB: Exit 14	15.24 – 15.37	Extend deceleration lane	● ● ● ●	\$2.7M - 4.0M	Yes
I-77 NB: Exit 14	15.31 – 15.70	Extend acceleration lane	● ● ● ●	\$4.8M - 7.2M	Yes
I-77 SB: Exit 19	18.81 – 18.98	Extend acceleration lane	● ● ● ●	\$3.9M - 5.7M	Yes
I-77 NB: Exit 19	19.54 – 19.72	Extend acceleration lane	● ● ● ●	\$3.5M - 5.2M	Yes
I-77 SB	21.90 – 23.67	Construct median guardrail	● ● ● ●	\$0.6M - 0.8M	No
I-77 NB	22.19 – 22.73	Conduct superelevation correction	● ● ● ●	\$1.8M - 2.4M	No
I-77 SB	22.22 – 22.77	Conduct superelevation correction	● ● ● ●	\$1.8M - 2.3M	No
I-77 SB	25.50 – 26.00	Conduct superelevation correction	● ● ● ●	\$1.7M - 2.2M	No
I-77 NB	25.52 – 26.01	Conduct superelevation correction	● ● ● ●	\$1.6M - 2.2M	No

Table 5: I-77 Capital Improvement Summary: Bristol District

The following symbols represent the four performance measures:

● Crash Frequency and Severity | ● Crash Severity Rate | ● Total Delay | ● Incident Delay

Location	Mile Post From – To	Description	Performance Measures	Est. Cost (Low – High)	IOEP Project
Bristol District					
I-77 NB: Exit 24	24.71 – 24.97	Extend acceleration lane	● ● ● ●	\$3.6M - 5.2M	Yes
I-77 NB	26.34 – 26.67	Conduct superelevation correction	● ● ● ●	\$1.2M - 1.5M	No
I-77 NB	26.34 – 33.10	Construct outside truck climbing lane between New River Bridge and Red Hollow Road	● ● ● ●	\$75M - 190M	Yes
I-77 SB	27.88 – 28.56	Conduct superelevation correction	● ● ● ●	\$2.1M - 2.8M	No
I-77 SB	40.81 – 41.06	Conduct superelevation correction	● ● ● ●	\$1.0M - 1.3M	No
I-77 NB	42.09 – 47.10	Construct outside truck climbing lane between MM 42 and MM 47	● ● ● ●	\$111M - 160M	Yes
I-77 NB	60.73 – 61.42	Conduct superelevation correction	● ● ● ●	\$2.1M - 2.7M	No
I-77 SB: Exit 62	61.95 – 62.27	Construct auxiliary lane between acceleration lane and rest area deceleration lane	● ● ● ●	\$4.4M - 5.6M	Yes
I-77 SB: Exit 64	64.22 – 64.50	Extend acceleration lane	● ● ● ●	\$4.3M - 8.6M	Yes
I-77 NB: Exit 64	65.29 – 65.62	Extend acceleration lane	● ● ● ●	\$6.3M - 7.4M	Yes

NEXT STEPS

The targeted improvements on I-77 were evaluated at a statewide level against improvements from other interstates, using an evaluation method similar to the SMART SCALE process. While the IOEP prioritization process did not recommend for any I-77 improvements to be funded using IOEP funds, the targeted improvements identified are eligible to be funded through other mechanisms.

This study will be updated every four years to allow for the development of a new, prioritized list of improvements for consideration by the CTB.